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THE THIRD SOVIET COSMIC ROCKET
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Translated by Joseph L. Zygielbaum

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JET PROPULSION LABORATORY
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THE THIRD SOVIET COSMIC ROCKET

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Translated by Joseph L. Zygielbaum

On October 4, 1959 the Soviet Union successfully launched its third cosmic rocket. The purpose of this launching was the solution of a number of problems in the investigation of cosmic space. The most important of these problems was to obtain photographs of the Lunar surface. Of special scientific interest was the obtaining of photographs from that part of the Lunar surface which, due to the specific movement of the Moon, is inaccessible for observation from Earth and also parts of the Lunar surface which are visible from Earth,but under such small angles that they cannot be sufficiently studied.

For a detailed study of cosmic space and for the purpose of photographing the Moon, an automatic interplanetary station has been designed which was injected into a Moon rounding orbit by means of a multistage rocket. In strict correspondence with calculations, the automatic interplanetary station passed the Moon at a distance of several thousand km and as a result of the Lunar gravitation, the flight direction of the rocket was changed. This permitted a flight trajectory to be obtained,which made it possible to photograph the hidden side of the Moon, and also allowed for the transmission to Earth of gathered scientific information.

The accomplishment of the launching of the third cosmic rocket and the injection of the automatic interplanetary station into the calculated orbit required the solution of a number of new, very complicated scientific and technical problems. A multistage rocket, which was utilized for the injection of this station into the orbit, was distinguished by a highly complete construction and had powerful motors, which operated on high calorie fuel. The guidance system of the rocket on the acceleration sector has assured the achievement of high accuracy of the desired flight characteristics of the rocket.

Scientific investigations, which were conducted with the help of the automatic interplanetary station, made possible the gathering of many materials which are being processed at the present time. Of great scientific interest is the obtaining of photographs of the hidden side of the Moon. For the first time in history men were able to see this side of the Moon which was never visible from Earth.

The launching of the automatic interplanetary station testifies to the high level of development of our national Soviet science and techniques.

THE CONSTRUCTION OF THE AUTOMATIC INTERPLANETARY STATION

The automatic interplanetary station is a cosmic vehicle equipped with a complex system of radio-technical, photo-television, and scientific instrumentation, a special guidance system, installations for program control of the operation of the apparatus, a system for automatic regulation of the thermal regime inside the station, and power supply sources. (Fig. 1)

A special radio-technical system secures the measurement of all parameters of the station, enables transmission to Earth of television and scientific telemetric information, and also the transmission from Earth of commands which control the operation of the apparatus aboard the interplanetary station.

The guidance system has secured the guidance of the interplanetary station in cosmic space in relation to the Sun and the Moon, which is necessary for the purpose of photographing the hidden side of the Moon.

The operation of the instruments aboard the station is entirely controlled from ground points along radio waves and also by separate programming devices aboard the station. Such a designed system makes it possible to control, most conveniently, the execution of scientific experiments, and to obtain information from various parts of the orbit within the limits of radio communication from ground observational points.

For the purpose of maintaining the desired thermal regime inside the station, an automatic system of thermal regulation, (a thermostat), functions continuously. This system assures the elimination of heat which is emanated by the instruments, through a special radiational surface into the surrounding cosmic space. For the purpose of regulation of heat emanation, special shutters are installed on the outside of the instrument carrier, which uncover the radiational surface during temperature increase inside the station to +25C.

The power supply system contains separate blocks of chemical power sources, which secure power to the short lasting activities of the instruments and also to the centralized block of a chemical buffer battery. Compensation of the consumed energy of the buffer battery is done by Solar power sources. Power is fed to the instruments aboard the station by means of converting and stabilizing installations.

The complex of scientific instrumentation, which is installed aboard the automatic interplanetary station, permits the further development of investigations of cosmic space and the space around the Moon, which was begun by the two previous Soviet cosmic rockets.

The automatic interplanetary station is composed of a thin walled hermetic construction, which has the shape of a cylinder with spherical ends. The maximum diameter of the station is 1,200 mm and the length is 1,300 mm (without antennas). Inside the body, on a frame, are distributed the instruments and the chemical power supplies. On the outside are installed parts of the scientific instruments, antennas, and sections of Solar batteries. On the front end is located the illuminator with a cover which opens up automatically before the start of photographic activities. On the top and bottom covers are located small illuminators for Solar devices of the guidance system. On the bottom sphere are installed the motors of the guidance system. (Fig. 2)

For the purpose of photographing the Moon, a scheme by which the photo cameras were directed at the Moon by turning the entire automatic interplanetary station, proved to be most useful. The orientation system which was installed aboard the station turned,and maintained the necessary direction of the automatic interplanetary station.

The orientation system was activated after nearing the Moon at the moment when the station was located in the desired position in relation to the Moon and the Sun. This secured the necessary conditions for orientation and photographing. The distance to the Moon, at this moment, was between 60 and 70,000 km,according to calculation. In the beginning of its operation the orientation system,which contains optical and gyroscopical devices, logistic electronic installations and guidance motors, first of all stopped the free rotation of the automatic interplanetary station around the center of its gravity, which began at the moment of separation from the last stage of the carrier rocket.

The automatic interplanetary station is illuminated by three bright heavenly bodies, the Sun, the Moon, and the Earth. Its flight trajectory was chosen in such a manner that at the moment of photographing, the station was located in approximately a straight line between the Moon and the Sun. At this moment the Earth should have been in such a position between the Sun and the Moon that there would be no possibility of the instrument becoming orientated on the Earth instead of the Moon.

The indicated position of the interplanetary station in relation to heavenly bodies, at the moment of the start of orientation, has permitted utilization of the following reception. First, its bottom sphere was directed towards the Sun with the help of the Solar sensors; with this alone the optical axis of the photocameras was turned in the opposite directions, towards the Moon. Then the respective optical installation, in whose field of view the Earth and the Sun could no longer appear, has sent off the orientation on the Sun and has conducted an accurate orientation on the Moon. The signal of Lunar "presents", which were sent out by the optical installation, permitted the start of automatic photographing. During the entire period of photographing, the system obtained a continuous orientation of the automatic interplanetary station on the Moon.

After all frames of the film were exposed, the orientation system was automatically turned off. At the moment of the turn off, it broadcast to the automatic interplanetary station, a regulating rotation with a determined angular velocity, which was selected in such a manner that on one side it would improve the thermal regime and on the other side it would eliminate the influence of rotation on the functioning of the scientific instrumentation.

THE FLIGHT OF THE INTERPLANETARY STATION

The orbit of the automatic interplanetary station was specially adapted for the solution of complex scientific problems. In order to obtain the necessary orbit, in addition to securing the required velocity and flight direction of the station at the moment of motor cutoff of the last rocket stage, the influence of the Lunar gravitation was also utilized.

The trajectory of rounding the Moon had to satisfy a number of requirements. For the purpose of securing a correct operation of the orientation system at the moment of photographing it was necessary, as was indicated above, to ascertain that at the moment of the start of orientation, the Moon, the station, and the Sun were located approximately on a straight line. The distance of the station from the Moon during the period of photographing was approximated at from 60--70,000 km.

The character of the trajectory necessitated the accumulation of a great deal of information during its first turn,and especially at close distances from the Earth's surface. In order to fulfill this requirement it was necessary to secure the best possible conditions of radio communication with the interplanetary station from points which were located along the territory of the Soviet Union.

For the purpose of scientific investigations it was also very desirable to obtain a trajectory which would secure a sufficiently long lasting flight of the interplanetary station in cosmos.

A flight around the Moon with a return to Earth can be accomplished during movement along various types of trajectories. In order to obtain such trajectories the velocity at the end of the acceleration sector should be somewhat less than the so-called second cosmic velocity, or the parabolic velocity, which equals 11.2 km/sec near the surface of the Earth. If the flight trajectory goes past the Moon at a distance of several 10,000 km from its surface, then the Lunar influence will be comparatively small, and the flight in relation to Earth will take place along a trajectory which would be somewhat elliptical, with its focal point at the center of the Earth. (Fig. 3)

However, a trajectory with a broad rounding of the Moon, which would carry a rocket at a distance of several tens of thousands km from the Lunar surface at its closest point, has a number of shortcomings. During a flight at great distances from the Moon, it becomes impossible to investigate directly the cosmic space in the immediate areas of the Moon. During the rocket launching which was accomplished from the northern hemisphere of the Earth, a return to Earth takes place from the southern hemisphere, which makes it difficult to conduct observations and receive scientific information from tracking stations which are located in the northern hemisphere. The movement near the Earth during the return trip takes place outside of the visibility limits from the northern hemisphere, therefore the reception of information concerning the result of scientific observations prove to be impossible near the Earth. During its return to Earth the rocket enters the dense layers of the atmosphere and burns up; i.e., the flight of the rocket ends after its first orbit.

These shortcomings can be prevented if, during the flight around the Moon, a type of trajectory is utilized, which carries the rocket at small distances approximately several thousand km from the Lunar surfaces.

The flight trajectory of the automatic interplanetary station passed at a distance of 7,900 km from the center of the Moon, and was selected with such a calculation, that at the moment of maximum approach, the station was to the south of the Moon. As a result of Lunar gravitation, the trajectory of the automatic station in correspondence with calculations was declined toward the north. This declination was so substantial that the return to Earth took place from the northern hemisphere. After approaching the Moon the largest altitude of this station above the horizon for observation points, which were located in the northern hemisphere, increased from day to day. The time intervals, during which a direct communication with the automatic station was possible, increased correspondingly. By a sufficient approach to the Earth the automatic station could be observed from the northern hemisphere as a stationary heavenly body.

Conditions for reception of information during the station's approach to Earth and conditions for conducting scientific investigations on the sector of return to the immediate environment of the Earth, proved to be sufficiently satisfactory. During the return to Earth in its first orbit, the station did not enter the atmosphere- which would have caused its disintegration-, but passed at a distance of 47,500 km from the center of the Earth, traveling along an extended orbit of very large dimensions, which resembled an ellipse. The largest distance of the station from Earth was 480,000 km.

Thus, by passing near the Moon, it was possible to obtain flight trajectories of the automatic interplanetary station which are extremely interesting, and it was also possible to conduct scientific investigations and to receive scientific information.

The flight of the interplanetary station near the Earth took place at such great distances from its surface that there was no drag due to atmospheric friction. Therefore, if the flight would take place only under the influence of the Earth's gravitational pull, the automatic station would have turned into an Earth satellite with an unlimited life span.

Actually, however, the life span of the station is limited. As a result of the perturbing influence of Solar gravitation the closest distance of the orbit to the Earth-the orbital perigee-would regularly decrease. Therefore, after completing a certain number of orbits, the station will, in its time, during one of its consecutive returns to Earth, enter the dense layer of our atmosphere and disintegrate.

The magnitude of altitude decrease of the perigee for one orbit depends on the dimensions of the orbit, and particularly on the altitude of the apogee, i.e., on the largest distance of the orbit from Earth, sharply increasing during the increase of the apogee altitude. This is why, during the selection of the trajectory for the interplanetary station, it was necessary to make an effort towards achieving an apogee altitude which would be somewhat less, and which would somewhat exceed the distance from the Earth to the Moon. It was also necessary that the altitude of the perigee during the first orbit be somewhat larger. The complete number of revolutions of the automatic interplanetary station around the Earth, and the period of its existence, depend on the degree of accomplishing these two assigned requirements.

The Lunar influence is not limited by this effect, which the Moon has inflicted during the first close approach. The perturbance of the station's orbit caused by the Lunar gravitation will not have such a regular character as the perturbation caused by Solar gravitation, and to a great degree it depends on the rotation period of the station around the Earth. The influence of the Moon can prove to be substantial, if at some of the consecutive orbits a repetition of a sufficiently close approach to the Moon would occur. In this case the approach of the station to the Moon would have taken place approximately in the same position as the Lunar orbit the first time. In case of a repetition of a close approach, the flight character of the station might change substantially. If the interplanetary station would pass the Moon from the south, i.e., if the second approach would be of a similar nature to the first, then the number of orbits and period of existence of this station would increase sharply by conserving the basic property of its trajectory-an approach to the Earth from the northern hemisphere. If a repetition of approach would take place from the northern side, the height of the orbital perigee would decrease, and in the case of a sufficiently strong perturbance, a collision with the Earth might take place during the next return of the station towards our planet.

During the orbital turns, when a close approach to the Moon does not take place, the Moon, nevertheless, has a certain influence on the movement of the station. Even if the gravitational force of the Moon in this case is very small, by affecting a considerable number of turns of the trajectory, the gravitation of the Moon shows a noticeable influence on the movement of the automatic station, causing a decrease in the perigee height and in the existence period of the station in orbit. (Fig. 3)

The picture of movement of the automatic interplanetary station, under the influence of simultaneously acting gravitational forces of the Earth, Moon, and Sun,is very complicated. The manner of passing the Moon during the first approach has a determining role for the future flight of the interplanetary station.

Since the flight of the interplanetary station cannot be corrected along its path, and its entire motion is finally determined by the flight parameters at the end of the acceleration period (basicly by the magnitude and direction of velocity), it is therefore clear that the realization of the above described trajectory of the cosmic station is possible only through an extremely perfect guidance system of the rocket carrier during the acceleration sector.

Calculations indicate that a declination from the assigned point of the stations passage through a pictorial plane, even only by 1,000 km, will change the minimum distance between the Earth and the station during the stations return at about 5 to 10,000 km, and the period of the closest approach to Earth will be changed from 10 to 14 hr. In this case,we call a pictorial plane the plane which runs from the center of the Moon perpendicularly to the line between the Moon and the Earth.

It was necessary to achieve an accuracy of control in the sector of the rocket's injection which would secure a declination in the point of intersection with the chartered plane that was not more than 3,000 km. This was necessary to achieve a limited deviation in the minimum distance between the Earth and the station which would not exceed 20,000 km. At first sight, this condition, which was presented to the rocket's guidance system, seemed to be less important in comparison with other conditions which govern the problem of hitting the Moon; since in order to secure an impact, a limited deviation of the rocket from the point of aim or from the calculated point of passing the pictorial plane did not exceed the radius of the Moon, i.e., it should be approximately two times smaller than 3,000 km. However, in the case of the rocket's movement along a rounding trajectory, a deviation in the rocket orbital injection would affect the crossing point on a chartered plane, considerably more than for an impact experiment like the one accomplished with the second cosmic rocket.

Actually, as was reported, a declination in the injection velocity of the rocket along a sector of free flight by 1 m/sec, in the case of a Lunar impact, would lead to a declination of the crossing point of the pictorial plane of 250 km, and in the case of an experiment with a rounding trajectory around the Moon,this deviation would equal 750 km, that is three times larger. By a comparison of these numbers it is obvious that a realization of the given experiment of a rounding trajectory presents not less, but even more, difficult requirements as far as the accuracy of the rocket guidance system is concerned, than in the case of a direct impact.

As previously mentioned, when the interplanetary station passes near the Moon, the station trajectory is subjected to strong perturbances, which cause a change in the initial direction of movement stipulating the return of the station to Earth from the site of the northern hemisphere. This same disturbing influence of the Moon substantially strengthens the effect of the deviation of the flight parameters at the end of the acceleration period from their calculated values and also the character of flight of the station during its return to the Earth after rounding the Moon. Therefore, even a small error in the determination of these parameters will lead to very substantial errors in the calculation of the characteristic of flight of the interplanetary station during its return to Earth.

For the purpose of establishing a reliable radio communication between the interplanetary station and the ground observation points, it was necessary to know in addition, and with sufficient accuracy, the changes which the characteristic of the stations flight underwent with time. This is necessary for the purpose of accurately conducting the calculations for target designation of the measurement points, and is necessary in determining the moments when the stations transmission instruments should be turned on. This requires a systematic measurement of the trajectory of the interplanetary station, a data processing, and a definition of the flight characteristics of the station during its approach to the Moon, as well as after the station's rounding the Moon. The influence of the Sun and the Moon on the evolution of the orbit of the interplanetary station, during the process of its further flight, also requires the constant measurement and definition of flight characteristics of the station.

The described circumstances present complicated requirements in the operation of the automatic complex. The automatic complex is designed for measurements of trajectory parameters of the interplanetary station, prognosis calculation of its movement, calculation of target designation of measurement at observation points, and calculation of the moment when its transmission instruments aboard a station should be turned on in the course of the entire flight around the Earth.

The instrumentation complex consists of radio technical stations for distance measurement, angular parameters, and radial velocity of the object's movement, a receiving station for telemetric information, and an automatic communication line between the measurement points at the coordinating computation center. This computation center is connected with ground stations, which issue the command to turn on the transmitting devices aboard the automatic interplanetary station.

A commanding radio line allows the radio technical means of the interplanetary station to be turned on at predetermined intervals of time, which correspond with the best possible conditions of radio communication between the stations instruments and ground tracking stations that are distributed along the territory of the Soviet Union.

The selection of duration and time for turning on the radio communication with the station is made by securing necessary information for the definition of flight characteristics and prognosis of the interplanetary station, and also by preserving the balance of energy of the instruments aboard the station.

At the present time preliminary data processing of the results of trajectory measurements has shown that the automatic interplanetary station will travel along its orbit until April of 1960, and will complete from 11 to 12 orbits around the Earth.

PHOTOGRAPHING AND TRANSMISSION OF IMAGES TO EARTH

During the development process of the methods for photography and transmission of images of the hidden side of the Moon from the automatic interplanetary station, the problem of a photo-television system was successfully solved. This photo-television system is necessary in order to obtain qualitative half-tone images and to transmit these images over a distance which is measured in hundred thousands km. A number of complicated scientific technical problems was solved by this.

At the time of photographing pictures the orientation system has been placed in such a position in the automatic station as to put the Lunar disc in full view of the camera lenses.

The construction of the photo-television instrumentation has secured its operational capability under the complicated conditions of cosmic flight. The photo materials which would be harmed under the influence of cosmic radiation were preserved, and the normal operation of the processing block of photo materials and other blocks of the instruments, under weightless conditions was assured.

For the purpose of transmitting images extra long distances, with a very low power radio transmitter, a transmission velocity of images was applied. This was tens of thousands times slower than the transmission speed of common broadcasting television stations.

During the first photographing of the other side of the Moon, it was advantageous to take pictures of the largest possible part of its unknown surface. This necessitated photographing a fully illuminated disc, the contrasts on which are always considerably lower than a side illumination,which creates shadows caused by the topographical details. (Fig. 4)

For better transmission of a low contrast picture, the photo-television cameras were supplied with an automatic brightness regulator in the diaphanous tube.

For reliable operation of the instrumentation complex under variable conditions the principal of self regulating schemes was applied. The harmony and operational regulation of all sections, including the electronic scheme, optical, mechanical, and photo-chemical installations, was accomplished by a special automatic and programming system.

The photo-television apparatus, which was installed on the interplanetary station, contains some basic constructions, including a photocamera with two objectives with a focal range of 200 and 500 mm. This made it possible to conduct simultaneous photographing in two different scales. The objective with a focal range of 200 mm reproduced an image of the disc which fully fit into the frame of the film. The close up image,which was reproduced by the objective with a focal range of 500 mm,was larger than the limits of the photo frame and gave a more detailed picture of a part of the Lunar disc.

The photographing process was conducted with an automatic change of exposures so that negatives with most convenient densities could be obtained. This process continued for about 40 minutes. During this time the other side of the Moon was photographed repeatedly.

Photographing was commenced by a command signal after the objectives were directed at the Moon. The following photographing process and film processing was conducted automatically according to a designed program. Photographs were taken on a special 35 mm film which withstood processing under high temperatures.

In order to prevent film fogging under the influence of cosmic radiation, special shielding was provided. This shielding was selected on the basis of investigations conducted with the help of Soviet artificial satellites and cosmic rockets.

After determination of the photographing experiment the film was transfered into a small dimensional device for automatic processing, where its development and fixation was conducted.

For the processing a special process,which secured a low dependence of negative parameters on temperature,was adapted. Preventive measures were taken to avoid destructive effects in the processing under weightless conditions. After processing, the film was dried and the moisture absorbed, in order to secure a lengthy preservation of the film. After finishing the processing, the film was transfered into a special cell and was prepared for transmission of its image to Earth.

Experimental signs were pre-exposed on the film, a part of which was developed before the rocket launching. Another part was developed aboard the station during the processing of the exposed frames, with the image of the other side of the Moon. These signs were transmitted to Earth and made possible a check run on the process of photographing, processing, and transmission of the images.

For the purpose of converting the images on the film negatives into electrical signals, a small size diaphanous cathode ray tube of a high resolution capability and a photoelectronic multiplier of high stability were utilized.

The transmission of the photographic images to Earth was accomplished in a manner similar to which movies are televised by TV stations.

In order to decline the ray of the cathode ray tube, economical low-frequency, rectifying devices were applied. Amplification and signal formation of the image was accomplished by a specially designed narrow band stabilized amplifier with a device for automatic compensation of the change in the mean density of the negative and the output signal. All schemes were accomplished basicly on semi-conductors.

A picture transmission under two conditions was provided: a slow transmission at large distances, and a rapid transmission at close distances during the station's approach to the Earth.

The television system has permitted the number of lines which make up the image depending on the conditions of transmission to be changed. The maximum number of lines was up to 1,000 per one frame of film.

For the purpose of synchronization of the transmitting and receiving rectifying installations, a method was utilized which secured a high interference stability and a reliability in the operation of the apparatus.

Photographs of the Moon were transmitted from the automatic interplanetary station along a radio communication line. At the same time this was used for measurements of flight parameters of the station itself, namely: distance, velocity, and angular coordinates, and also for transmission of results of scientific experiments with the help of telemetric instruments. The turning on and off of various instruments aboard the station and the changes in their operational regimes,was conducted by special commands which were transmitted from Earth to the station along the same radio channel.

The transmission of Lunar images,and all other functions in the line of radio communication from the station,was accomplished with the help of a continuous radio wave propagation, contrary to the impulse radiation which was used earlier in some cases. Such a combination of functions over one radio channel by a continuous radiation was conducted for the first time, and made it possible to secure a reliable radio communication up to maximum distances with minimum energy consumption aboard the station.

The line of radio communication from the station consisted of two parts,-a line "Earth-Station" and a line "Station-Earth",-and included commanding installations, powerful radio transmitters, highly sensitive receiving and recording devices, and antenna systems, which were located at ground points of radio communication. It also consisted of transmitting, receiving, and antenna constructions installed aboard the interplanetary station. In addition, aboard the station were located commanding and programming radio technical instruments.

The entire instrumentation of radio communication lines aboard the station, as well as at ground tracking stations, was duplicated in order to increase the reliability of communication. When one radio technical instrument aboard the station did not function properly, or its operational resources were exhausted, it could be replaced by a reserve unit by means of transmitting a necessary command from the ground control center.

The transmission of Lunar images was conducted by a command from Earth. With these commands the power supply of the television cameras aboard the station, the feed of film, and also the attachments of the television cameras to the stations transmitters were turned down. As a result the order of brightness change along the lines which make up the image was transmitted to Earth.

The over-all extent of scientific information which was transmitted along radio communication lines, including photographic frames of the Moon, has by far exceeded the extent of information which was transmitted from the first and second Soviet cosmic rockets.

For the purpose of a reliable transmission of this information in the presence of a considerable noise level of cosmic radio propagation, an especially effective method of radio communication was applied. This assured a minimum energy consumption from the power supplies aboard the station.

In consideration of economy of electrical energy, the power of the radio transmitters aboard the station was established to be of several watt. Semi-conductors and other contemporary materials were used in the construction of the receiving and transmitting radio stations aboard the interplanetary station. Special care was taken to achieve minimum dimensions and weight of the instruments.

If we take into account the percentage of magnitude which is propagated by the radio transmitter from aboard the station which reaches the ground receiving stations, it is possible to understand the difficulties which were encountered in securing a reliable radio communication with the interplanetary automatic station.

To secure a continuous communication with the station during its rotation, the station's antennas propagate radio signals uniformly in all directions to enable the propagation magnitude which falls on a unit of surface to be equal for all points of the imaginary sphere, the center of which is the interplanetary station.

The ground receiving antenna picks up a part of the propagation magnitude, which is determined by the correlation of the effective area of the receiving antenna to the surface of the sphere with a radius which equals the distance from the station to the receiving points. Therefore huge receiving antennas are used for the reception of signals from the station.

However, even in this case, with a maximum departure of the station from the Earth, the received parts of propagation magnitudes from the transmitter aboard the station is a hundred millions times less than the mean magnitude which is received by a common television receiver. For the reception of such weak signals it is necessary to have very sensitive receiving installations with a low level of output noises.

The noises on the output of the ground receiver consist of cosmic radio propagation noises, which are received by the antenna, and natural noises of the receiver, which were reduced to a minimum through the adaption of special measures. The decrease of the noise level, as a rule, is connected with a decrease of the transmission speed of information.

In conjunction with the above described, in line of radio communication, methods of processing and transmission of signals aboard the station and at the ground receiving points were applied, which reduced the noise level at a maximum degree and preserved the same transmission speed.

An economical utilization of the power supplies aboard the station, the presence of a radio communication line with a continuous propagation and combined functions, the application of specially designed antennas and highly sensitive receivers on Earth, utilization of special methods of processing and transmission of signals, - all of these combined - has permitted a reliable radio communication with the automatic interplanetary station, a reliable operation of the commanding radio lines, and a planned reception of Lunar images and telemetric scientific information.

Signals of television images, which were received by ground receiving stations, were recorded by various instruments; this made it possible to control the course of transmission and to eliminate spe specific distortions which were caused by peculiarities of the radio communication lines and the recording instruments.

The functions of the signals of the Lunar images was conducted on special recording devices for television images on a photographic film, on instruments for magnetic recordings with a high stability in the speed of movement of the magnetic tape, and skiatrons (cutoff-ray tubes with a lengthy preservation of images on the screen), and on recording instruments with a registration of images on electro-chemical paper. The materials which were obtained from all forms of recording are utilized during the study of the hidden side of the Moon.

With the help of the television system which was installed aboard the interplanetary automatic station, the transmission of images was accomplished at a distance up to 470,000 km. This has initially and experimentally confirmed the possibility of transmitting very clear half tone images without substantial specific distortions during the process of radio wave propagation through cosmic space for very great distances.

THE HIDDEN SIDE OF THE MOON

The rotation period of the Moon around its axis coincides with the period of its rotation around the Earth. Therefore the Moon always faces the Earth with the same side. Millions of years ago the Moon rotated around its axis much faster than it now does, and completed one revolution in a period of several hours.

The forces of tidal friction which were caused by the gravitation of the Sun and the Earth have slowed down the Moon, extending the period of its revolution around its axis, and have caused this revolution to last over a period of 27.32 days.

Although the telescopic study of the Moon has been carried on for more than three and a half centuries, up to now charts could be made of only the visible part of the Moon. On these charts are defined the circular mountains, mountain chains, dark regions of the Lunar crust (which were the named "seas"), and other formations.

Roughly, 59% of the Lunar sphere is visible from Earth. On this part of the Moon many formations are located on the very edge of the visible Lunar disc and, therefore, they could not be studied in detail, due to strong perspective distortions. The fact that from Earth it is possible to study a little more than half of the Lunar disc, is explained by the presence of so called Lunar librations, i.e., the tilting of the Moon as seen by an observer from Earth. Photographing the Moon from aboard the interplanetary cosmic station was conducted at the moment when the station was located on a line which connected the Sun and the Moon, that is, when in respect to the station the Moon represented a fairly illuminated disc. On the Lunar photograph the boundary of the visible and invisible from Earth, part of the Moon is defined by a broken line.

The photograph presents a part of the Lunar surface which is invisible from Earth and also a small region of already known formations. The presence of this region on the photographs made it possible to connect objects of the Lunar surface, which were never observed, to already known formations and to determine thus their selenographic coordinates.

Among the objects which were photographed from aboard the interplanetary station and which are visible from Earth are the following: Humboldt's Sea, the Sea of Crises, Border Sea, Smyth's Sea, a part of the Southern Sea, and other formations. (Fig. 5 and 6)

These seas, which are located near the very edge of the Lunar disc and are visible from the Earth, seem to us to be very narrow and long due to perspective distortions, and their actual form was not determined until the present time. On the photographs which were taken from aboard the interplanetary station, these seas extend far from the visible rim of the Lunar disc and their form is very little distorted through perspectivity. Thus, we learned for the first time the original form of a number of Lunar formations.

It is noticeable that on the available photographs of the hidden side of the Moon, mountain regions prevail when there are only few seas similar to the ones on the visible part of the Lunar disc. Crater seas which are located in the southern and near equatorial regions stand out sharply.

From the seas which are located near the boundary of the visible Lunar part, in strong foreshortening, Humboldt's Sea, the Marginal Sea, Smyth's Sea, and the Southern Sea can be distinguished on the photograph almost without distortions. It was found that the largest part of the Southern Sea is located on the other side of the Moon, and its boundaries have an irregularly curved form.

Smyth's Sea, in comparison with the Southern Sea, has a more rounded form and is penetrated from the south by a mountainous region. The Marginal Sea is somewhat extended in the northern direction,and on the opposite side from the Sea of Crises, it has a depression.

Humboldt's Sea is of a unique pear-like form. The entire region which is adjacent to the eastern boundary of the other side of the Moon, (i.e., to the Marginal Sea), has an interstitial reflecting power between the mountainous areas and the Seas. With its reflecting power it is similar to the region of the Moon which is located between the craters Tycho, Petavius, and the Sea of Nectar.

To the south, southeast of the Humboldt Sea, on the border of the above indicated region, is located a mountain chain which extends for more than 2,000 km, crossing the equator and extending into the southern hemisphere. Beyond the mountain range is located a broad continent with an increased reflecting power.

In the region which is located between 20 deg and 30 deg of northern latitude,and 140 deg and 160 deg of eastern longitude, a crater sea with a diameter of about 300 km can be seen. In the south this sea terminates with a bay. In the southern hemisphere, in the region with the following coordinates, latitude 30 deg and longitude +130 deg, a large crater is located with a diameter of more than 100 km and a dark bottom with a bright central mountain, which is surrounded by a light colored broad wall.

To the east of the above mentioned range, in the region of +30 deg northern latitude, is located a group of four craters of medium size, the largest of which has a diameter of about 70 km. To the southeast of this crater group, in the region with the coordinates of +10 deg latitude and +110 deg longitude, can be seen a separate crater of a circular form. In the southern hemisphere, near the eastern rim, are located two regions which sharply decreased reflecting powers.

In addition, the photographs contain separate regions with slightly increased and decreased reflecting powers and numerous small details. The nature of these details, their form, and dimensions, will possibly be established after a thorough study of all photographs.

The success in accomplishing television transmissions of images of the invisible part of the Lunar surface from aboard an interplanetary station for the first time opens broad perspectives for the study of planets of our Solar system.

The flight of the third cosmic rocket has turned a new page in the history of science.

Penetrating into cosmic space, a Soviet cosmic rocket will now continue to send to Earth not only information about the physical characteristics of interplanetary environment and heavenly bodies, but also photographs of heavenly bodies in the vicinity of which these rockets will travel.

For the first time in history a television transmission of images from a distance measured in hundred thousands km was accomplished. Broad perspectives are open for astronomy which is now able to bring its instruments closer to heavenly bodies.

The first Soviet automatic interplanetary station has given a feeling of pride to all Soviet people; pride for its great Socialist country, and for the advanced Soviet science and technique. It has been hailed by all progressive people.

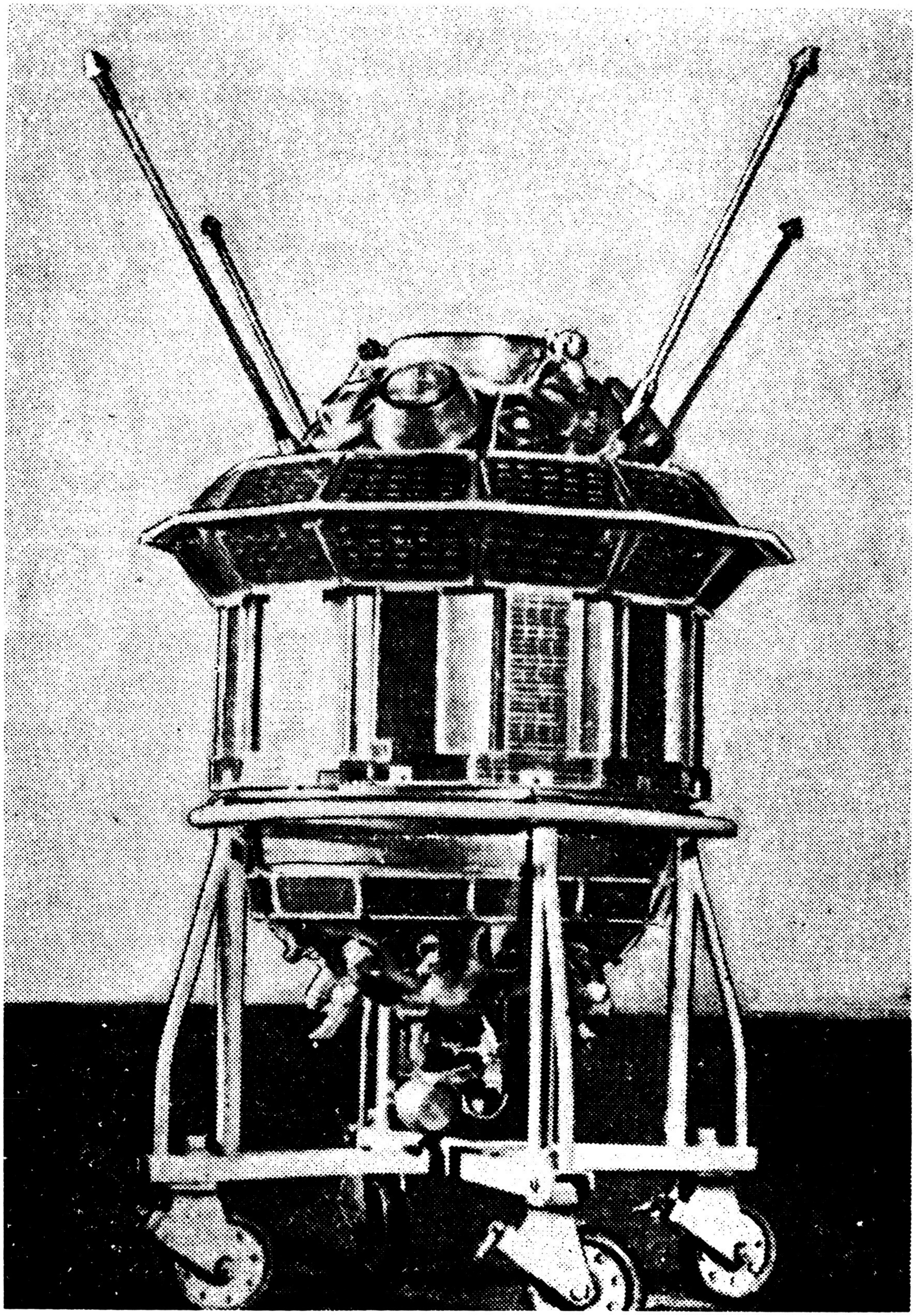

Fig. 1. Interplanetary Station on Assembly Cart

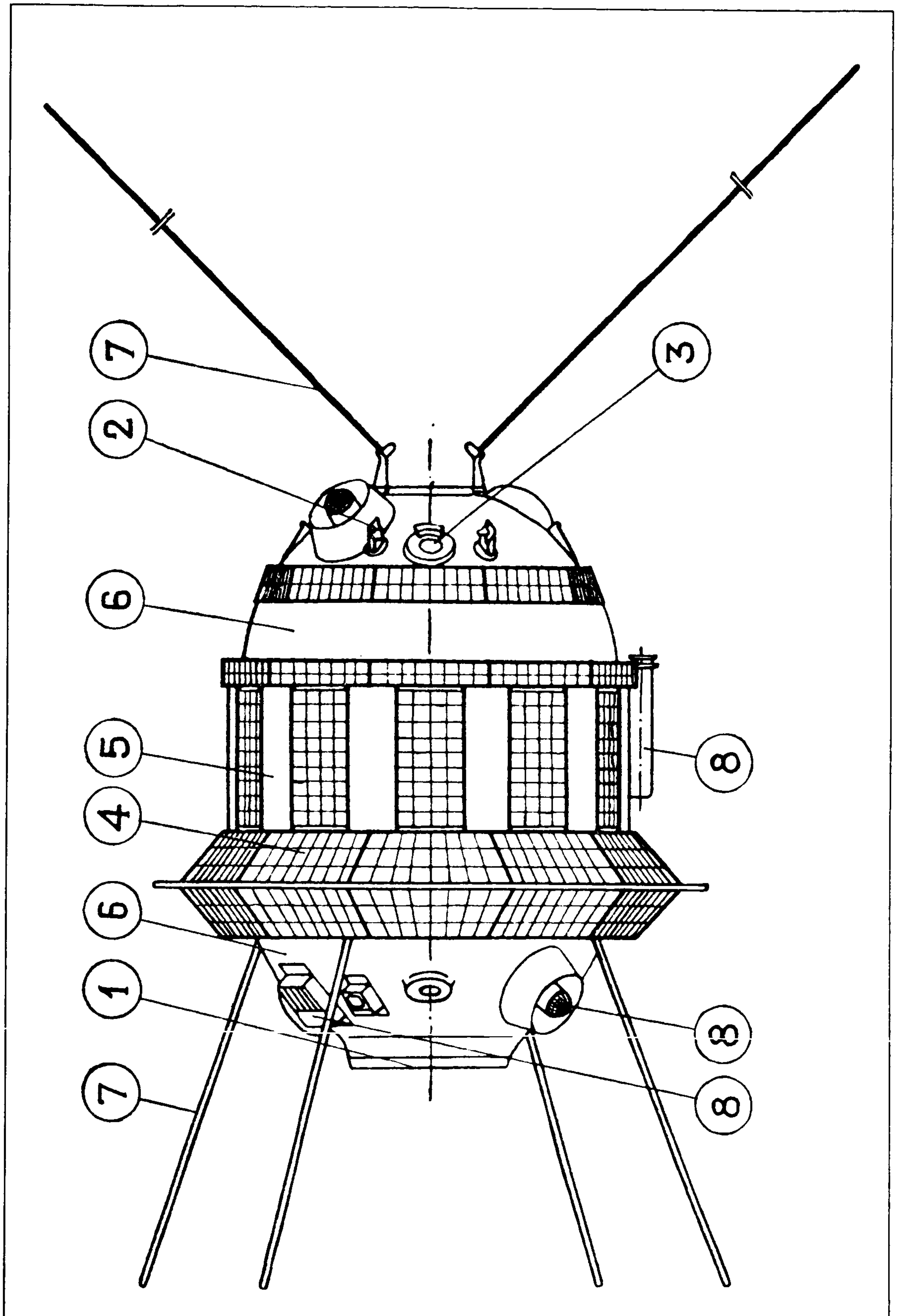

Fig. 2. Over-all View of Automatic Interplanetary Station

1. Illuminator for photo-cameras; 2. Motor of orientation system; 3. Sun sensor; 4. Section of solar battery; 5. Shutter of thermo-regulation system; 6. Thermal screens; 7. Antennas; 8. Instruments for scientific investigations.

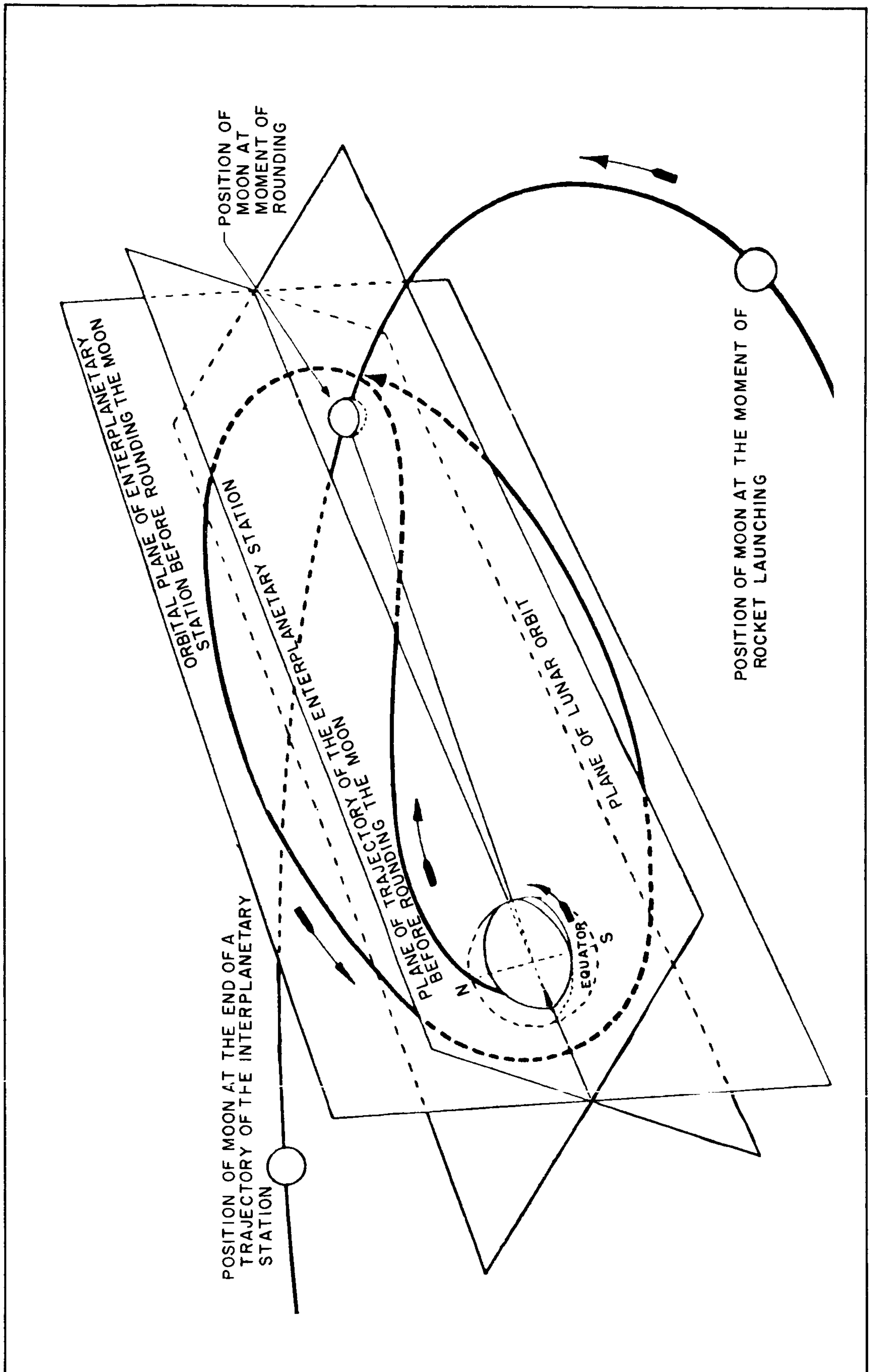

Fig. 3. Trajectories of the Third Soviet Cosmic Rocket

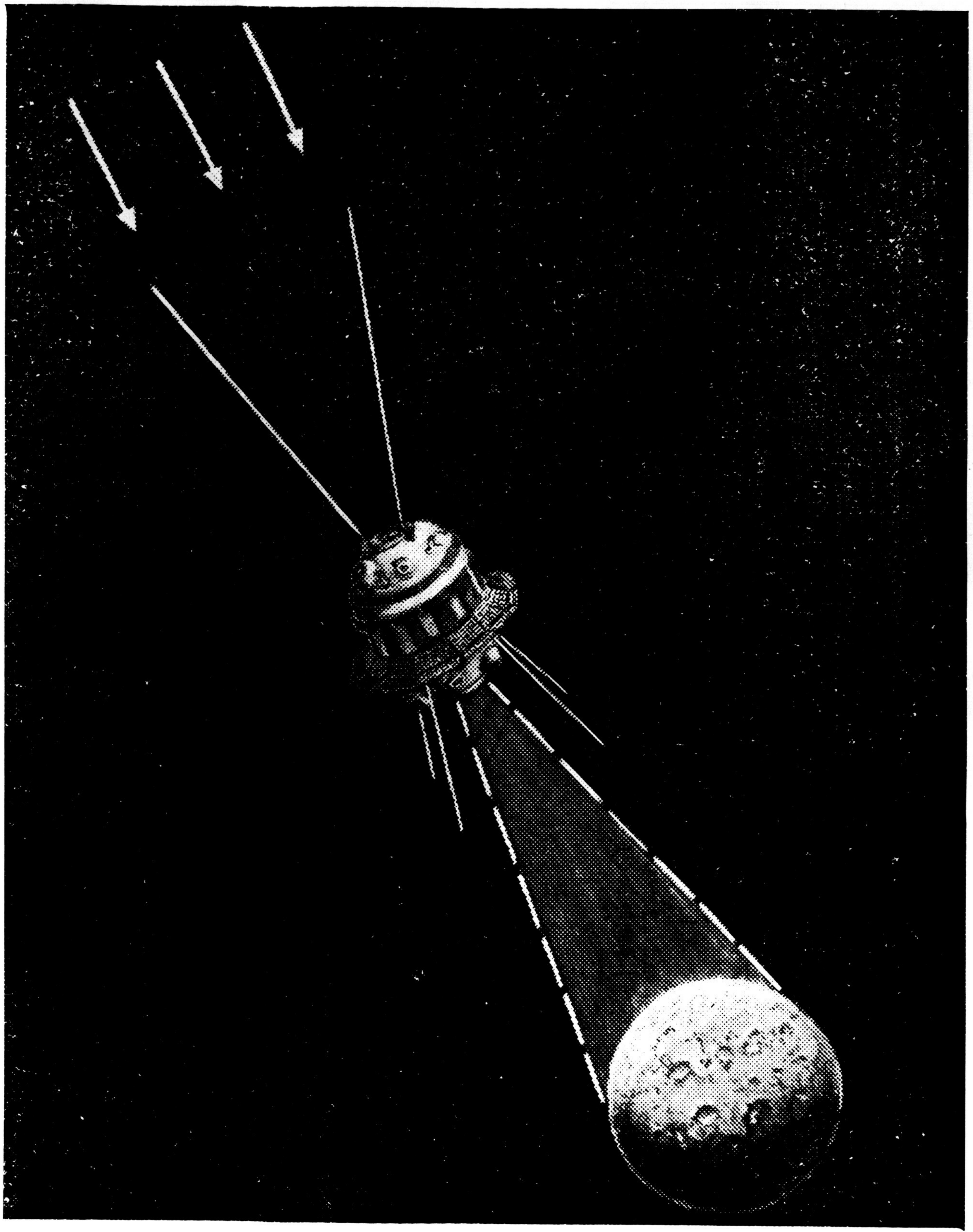

Fig. 4. Position of Interplanetary Station During the Photographing of the Hidden Side of the Moon

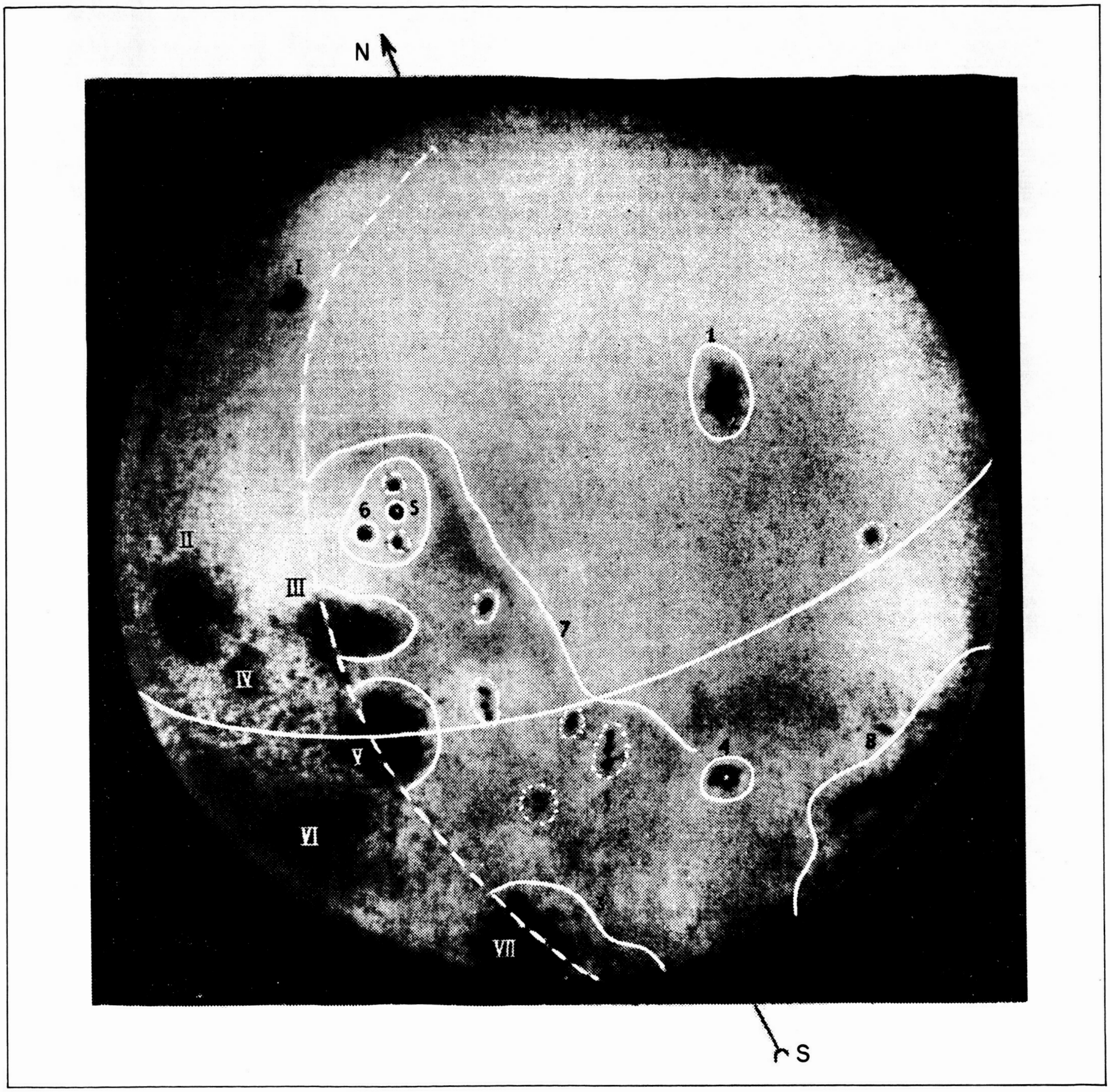

Fig. 5. Hidden Side of the Moon Photographed from the Third Soviet Cosmic Rocket

1. Moscow Sea (Large Crater Sea, dia. 300 km); 2. Bay of Astronauts; 3. Continuation of Southern Sea; 4. Tsiolkovsky Crater; 5. Lomonosov Crater; 6. Joliot-Curie Crater; 7. Sovietski Mountain Range; 8. Sea of Dremas (Myechta).

I Humboldt's Sea; II Sea of Crises; III Marginal Sea; IV Sea of Waves; V Smyth's Sea; VI Sea of Fertility; VII Southern Sea.

Fig. 6. Close-up of Hidden Side of the Moon